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**CAVE Visualization**  
 Ronald Kriz  
 Visualization and Animation Group  
 Virginia Tech

**List of VE Hardware and Software Technologies—Data Item #0001**

A complete list of VE hardware and & software for the current CAVE is located on the following web pages and noted below:

1. Hardware\*\*: [www.sv.vt.edu/future/cave/hardware/hardware.html](http://www.sv.vt.edu/future/cave/hardware/hardware.html)
2. Software: [www.sv.vt.edu/future/cave/software/software.html](http://www.sv.vt.edu/future/cave/software/software.html)

**Virginia Tech**  
**CAVE hardware**

List of CAVE hardware is given below. The actual CAVE structure and video projectors were provided by Pryamid Inc.

SUMMARY	
<b>SGI Onyx</b> , with 4 years on-site parts and care, 8X10000, 512MB Memory, 4GB System disk, 3IRs with 2RM64s / pipe. (detailed equipment list posted below)	\$ 704,377.
<b>Compuplus Inc.</b> , 1GB Kingston Memory	\$ 24,000.
<b>Exide</b> , 18KVA Power conditioner & UPS	\$ 16,400.
<b>Pyramid</b> , CAVE Installation Subcontract, Video projectors, frame, screens, pos. device, EVL subroutine library, license.	\$ 330,000.
<b>Installation</b> : Freight, Travel & per diem.	\$ 6,000.
<b>TOTAL COST</b>	\$ 1,080,777.

Row	Q ty	Model Number	Description	Unit Price
1.1	1	R-97804-IR	Onyx Infinite Reality Rack, 4X10000 w/2MB cache, 16MB tex mem, DG4-2, 64MB mem, 1IMB, 2GB sys disk	\$293,800
1.2	1	FTO-RM6-64	First 64MB Texture Memory Raster Manager card for Onyx Infinite Reality and i-Station systems	\$10,000
1.3	1	FTO-DG4-2	DG4-2 Two Channel Display card for Onyx InfiniteReality and i-Station systems	\$0.00
1.4	1	FTO-64UP512-2	First 512MB High Dens Mem, 2 way interleave, 1 IMB for CHALLENGE AND ONYX systems	\$40,320.
1.5	2	HU-IRPIPE-64-2	Add-on or Upg InfiniteReality Graphics subsystem for 2nd and 3rd pipe in Onyx Rack, 1 RM6-64, 1 DG4-2	\$130,000
1.6	1	HU-497G	Additional 4xR10000 w/2MB of secondary cache CPU board for all Onyx systems	\$100,000.
1.7	3	HU-RM6-64	Additional 64MB Texture Memory Raster Manager card for InfiniteReality systems	\$60,000.
1.8	1	HU-GFXCAGE-IR-U	Graphics Exp Cage for rack Onyx, PWR CHALL GR InfiniteReality systems, US Version, 1PC2	\$30,000.
1.9	1	FTO-2GBUP4G B-D	Upgrade 2GB to 4.3GB SCSI-2 fast, wide, differential System Disk for CHALLENGE and ONYX systems	\$3,000.

1.10	1	HU-PC2-A	Additional POWERchannel-2 for all Onyx systems	\$12,000.
1.11	1	D-M21G-NC	21-inch MultiSync Monitor for Onyx,, POWER Onyx, i-Station, Reality Station, POWER CHALLENGE Vis Console	\$0.00
1.12	1	SC4-W4D-6.2	IRIX 6.2 UNIX Software & Manuals for InfiniteReality, Onyx and Indy Workstations	\$0.00
1.13	1	DK-C2-001	Destination Kit for XL Series, ONYX Rack, 220VAC/1P	\$0.00
2.1	1	WB-TWO250H I2	INDIGO High IMPACT Graphics, 250MHz/2MB cache, 64MB Memory, 2GB System Disk, 20" Monitor	\$36,000.
2.2	1	D-M20NC	20" Multi-Scan Tilt-Swivel, Color Monitor	\$0.00

**Virginia Tech  
CAVE Software**

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### Software Developed at the VT-CAVE

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- **Atomview:** Collaboration between NCSA and VT  
 Creators: John Shalf / Ron Kriz (Summer Project at NCSA summer97)  
 SciViz Class Project Fall97: A. Goel / R. Narasimhan  
 VT-Contacts: Diana Farkas / Ron Kriz. [diana@vt.edu](mailto:diana@vt.edu) / [rkriz@vt.edu](mailto:rkriz@vt.edu)  
[NCSA Access Article](#)
- **Collaborative CAVE Console**  
 Creators: Kevin Curry / Kent Swartz  
  
 Present GRAs: Greg Edwards / Fernando das Neves  
 VT Contact: Ron Kriz / John Kelso: [rkriz@vt.edu](mailto:rkriz@vt.edu) / [kelso@vt.edu](mailto:kelso@vt.edu) The CCC was installed on the VT-CAVE, I-Desk, and Octanes in the CAVE Lab.
- **JIVE** (Just In a Virtual Environment): Special Study Summer99 Project  
 VT Contact: Chad Wingrave (540) 231-2060, [cwindgrav@vt.edu](mailto:cwindgrav@vt.edu)  
 Ron Kriz / John Kelso: [rkriz@vt.edu](mailto:rkriz@vt.edu) / [kelso@vt.edu](mailto:kelso@vt.edu)  
  
 JIVE will be installed on the VT-CAVE at the end of summer 1999 which will work with CAVERNsoft, LIMBO and our current version of CCC.
- **Eye Motion Tracking in the VT-CAVE**  
 VT Contacts: Deborah Hix / Randy Levensalor  
 (540) 231- 6199, [hix@vt.edu](mailto:hix@vt.edu) / [randyl@vt.edu](mailto:randyl@vt.edu)  
[Report](#) by Kevin Richey.

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### Commercial Software Installed on the VT-CAVE

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- **Alias | Wave Front (Campus Programs)** Contact:  
 Marlyn Hubble  
  
 (416) 362-9181  
 VT Contact: Bob Fields: [bob.fields@vt.edu](mailto:bob.fields@vt.edu)

Studio V8 installed on VT-CAVE with 9 cpu multiprocessor option

- Advanced Visualization Systems Contact:

Virginia Sales Office

(703) 481-9842

VT Contact: Ron Kriz: [rkriz@vt.edu](mailto:rkriz@vt.edu)

AVS was installed with NRL's Grotto-Viewer Module

- Sense8 Corporation / CAVE Display Option Contact:

Information

Erik Garrison Sense8 Corp.

(415) 339-3224

[garrison@eai.com](mailto:garrison@eai.com)

VT Contact: John Kelso: [kelso@vt.edu](mailto:kelso@vt.edu)

Sense8 WTK was installed for the Virtual Universe Project

World2World: Collaborative VR with WTK technical overview.

- Molecular Simulations Inc. Contact:

Amanda Porzio, Academic Account Manager

Molecular Simulations Inc.

5902 Erhardt Dr.

Riverview, FL 33596

(813) 661-2155

[amandap@msi.com](mailto:amandap@msi.com)

VT Contact: David Bevan: [drbevan@vt.edu](mailto:drbevan@vt.edu)

VT Contact: Diana Farkas: [diana@vt.edu](mailto:diana@vt.edu)

MSI software was installed

- MultiGen - Paradigm Inc. Contact:

Kristin Davis

MultiGen - Paradigm Inc.

14900 Landmark Blvd.

Dallas, TX 75240

(214) 960-2301

[kdavis@paradigmsim.com](mailto:kdavis@paradigmsim.com)

VT Contact: John Kelso: [kelso@vt.edu](mailto:kelso@vt.edu)

All of Paradigm and Multigen software was installed.

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**NCSA CAVE Software:**

- Crumbs Software: Created by the NCSA Biological Imaging Group (Rachel Brady)
- NCSA CAVE Software Interfaces (Bill Sherman).

**NCSA Software Contacts:**

- Applications Software on NCSA's High-Performance Computer Systems  
Third-party applications software and community codes available on NCSA high- performance computer systems are listed. The software list is also available in PostScript and ASCII (This list is only available online and is updated as changes occur) .

- NCSA Software Coordinators  
Please contact the appropriate software coordinator in your research area to discuss a particular application, licensing, or your applications software requirements. NCSA is always looking for new and more functional software to meet users' needs. The coordinators can help formal request for applications software on NCSA's HPCC systems: Connection Machine ModelCM-5, CONVEX Exemplar, and SGI POWER CHALLENGEarray.
  - SGI Workstation Software  
All software in this list is compatible with AFS and with the IRIX 5.2 operating system. Licensed, public-domain, and locally developed software codes are included.
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A comprehensive list of VR hardware and software vendor devices is given at CAVERNUS web page ([www.ncsa.uiuc.edu/VR/cavernus/](http://www.ncsa.uiuc.edu/VR/cavernus/)). In fact this list of systems has grown so large that it has created new problems where it is now difficult to create highly interactive systems that can accommodate the long list of APIs and devices. In response to this problem the Electronic Visualization Lab (EVL) has created TANDEM, NRL has created PANDA, and the VT-CAVE has created JIVE. I would add one API not show here on the list that I think is a very good but very costly API, this is Paradigm's Vega. Recently VEGA has included a VE tool to its GUI called Lynx and also the collaborative interactive tool called DIS (Distributed Interactive Simulation). I am sure the folks at NRL VR-Lab already know about VEGA and Lynx but I believe with these new features it deserves some consideration but perhaps the cost could be a factor.

**\*\* NOTE:** Does not include voice recognition and sound system and SGI Sirius video upgrade. These two systems will be included soon.

## Specs for VE tactical process prototype—Data Item #0002

The tactical processes involved in building an interactive collaborative CAVE like command center has already been outline by Simon Julier at the "Selected VR Lab Research Projects" (<http://www.ait.nrl.navy.mil/vrlab/pages/research.html> under the Battlefield Augmented Reality System). In the "Problem Statement" links have been made to "Concepts Division of the Marine Corps Combat Development Command". Because the tactical process has already been comprehensively outlined, our objective here is to show how our CCC concepts link to this predefined process.

Since the original NAVCIITI proposal was written, the NRL VR-Lab has changed it's focus from the Dragon Battlefield Visualization System to the Battlefield Augmented Reality System (BARS) and developing an interoperable VR system called Panda that is an extension of the Bambo software developed at the Naval Postgraduate School. This was largely motivated by the limitations on including multi-input and multi-output devices.

At Virginia Tech's CAVE we also experienced similar limitations of developing an interactive collaborative CAVE system that we called the CAVE Collaborative Console (CCC) based on CAVERN and LIMBO that was developed at the Electronic Visualization Laboratory (EVL). In our NAVCIITI proposal we originally proposed to extend the development of collaborative awareness tools in the CCC for tactical environments, such as 2D, 3D radar, etc. However, we discovered several serious flaws in the existing LIMBO software API and choose to invest our time in creating a new API that would allow the extension of new devices and other APIs in a new extensible interactive-collaborative environment that we called JIVE: ([www.caveslugs.vt.edu/projects/jive/](http://www.caveslugs.vt.edu/projects/jive/)).

It is interesting that the philosophy behind the CCC is very similar in concepts presented in the Interoperable Virtual Reality System (Panda) web pages.

CCC: [www.bleen.sv.vt.edu/~kcurry/ood.html](http://www.bleen.sv.vt.edu/~kcurry/ood.html)

Panda: [www.ait.nrl.navy.mil/vrlab/projects/interoperableVR.html](http://www.ait.nrl.navy.mil/vrlab/projects/interoperableVR.html)

Whereas Panda was based on Bambo, CCC was based on CAVERN and LIMBO. But we discovered that LIMBO has many serious limitations to properly implement CCC for reasons similar to NRL's experience. So this summer (1999) we started our effort to create JIVE not knowing about the parallel efforts at NRL to develop Panda. It is interesting to note that EVL for similar reasons has created TANDEM ([www.evl.uic.edu/cavern/seminars/limbos/index.html](http://www.evl.uic.edu/cavern/seminars/limbos/index.html)) and marketed TANDEM as a VRCO product ([www.vrco.com/products/beta\\_products.html](http://www.vrco.com/products/beta_products.html)). The biggest difference between TANDEM and JIVE is that JIVE is open source. We have not had the opportunity to study the differences between Bambo and JIVE but these would be of academic interest only and so at this point we will continue to develop JIVE under funding from our NSF PACI grant and work with NRL's Panda and Bambo if required. Actually this would not create any problem since our collaborative awareness tools for tactical implementation are all created using Performer. We will wait to hear from Larry Rosenblum's group if they want us to pursue working with Panda and Bambo to the completion of FY99 funding.

We have just learned that our efforts will take a huge change in direction starting October 1, 1999 for FY00 funding where we will be focusing on VE scientific data visualization of sonar and meteorological 3D data. In the next few weeks I will inquire if we should finish the tactical process prototyping or change our efforts this fall semester to start modeling 3D data visualization systems.

Comment-Recommendation: We have had many discussions with others in the VE world and we all share this frustration about co-development of similar tools such as TANDEM, JIVE, and PANDA for example. These independent efforts are mostly due to a lack of communication and there seems to be an agreement that what is needed is to create open source for CAVELibs and collaborative interface APIs such. This would facilitate the development of Panda and CCC.

### Recommended large format VE hardware—Data Item #0003

A report from Pyramid Systems Inc. on the design of a large CAVE format is available on request. The large CAVE format is briefly described as a 20' wide x 20' deep and 10' where the ceiling, not the floor is the fourth projection screen. The projection system requires two Electrohome 9500LC Ultras per 10'x10' areas where each is polarized at 90 degrees to each other, hence eliminating the use of stereo shutter glasses. The total number of projectors required for the 20'x20'x10' with a 20'x20' ceiling would require 20 projectors which constitutes the eighty percent of the total cost of the entire system. The total cost was quoted at \$620K. Twenty projectors would require a 10 Infinite Reality Pipe SGI ONYX-2 with at least 12 nodes. Such a computing system is called a Reality Monster that cost approximately \$1M. Together the large CAVE with computer would approach \$2M. The benefits of the large format CAVE would allow more participants to experience the immersive environment. Due to the cost alone when compared with the second year budget it is not advised to purchase the large format CAVE.